Project FY22-SW-009: Developing FHB Resistant Soft Red Wheat Cultivars for Maryland

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1. What are the major goals and objectives of the research project?

1) Breeding soft red winter wheat adapted to the Mid-Atlantic environment with resistance to scab and to increase the adaptation of FHB resistant lines by the wheat growers in Mid-Atlantic region.
2) Map and integrate new sources for FHB resistance in breeding germplasm and to enhance the collaborations with regional breeders.
3) Evaluation of advanced MD lines in Uniform Scab nurseries, Maryland State Test and Uniform Regional Nurseries and release of improved MD cultivars.

2. What was accomplished under these goals or objectives? *(For each major goal/objective, address these three items below.)*

What were the major activities?

Making FHB resistant germplasm using two-way and three-way crosses
The top 45 crosses were used for the speed breeding pipeline (100 lines per population)
Another top 25 crosses were used for DH generation (40 per population)
Implementation of genomic selection pipeline in the Md wheat breeding program for FHB and yield related traits.

What were the significant results?

1. Released two cultivars with enhanced FHB resistance
2. Advance breeding germplasm with more than 5 stacked QTL
3. Speed Breeding assisted fast-tracked FHB resistance breeding pipeline delivering improved cultivars
4. Enhanced FHB resistance in the MD germplasm. Our six MD lines (with excellent FHB resistance) were in the top 25 entries compared against several public and commercial wheat cultivars.
5. Licensing of two wheat cultivars with enhanced FHB resistance
6. Five new high-yielding lines with improved Fhb resistance are in the process of commercialization to private seed companies.
7. Advanced generation breeding germplasm combining Fhb1 and Fhb7 genes
8. Developed Fhb7 introgressive germplasm with no apparent linkage drag and shared the adapted Fhb7 germplasm in soft red winter wheat background with Southern-VDHR members.

List key outcomes or other achievements.

Based on three years of yield results and field performance, we licensed two wheat cultivars to two seed companies. These prospective cultivars have excellent FHB resistance. MDW148 is an awnless, high yielding moderately resistant to FHB with two staked FHB R QTL and MDW23-2 is an awned with moderately susceptible to scab and has 6A and 3A QTL.

Five new elite wheat cultivars MDW463-13 (Fhb1, Fhb1B), MDW-9-40, MDW555-4, MDW9-37 (Fhb1 and Fhb3A), and MDW1-9-6 (FHB1) with high yield and excellent FHB resistance, are advanced for commercialization.

3. What opportunities for training and professional development has the project provided?

Three PhD students, one MS student, one postdoc, three undergraduate and a high school student, were trained under this project. All the trainees worked with the PI to conduct the FHB screening of the mutant and natural populations in GH and misted nursery and participated in data collection and analysis. These students also participated in conferences and commodity board meetings with their work. High school student Joseph Wang and undergraduate student Ryan First presented their work in Mid-Atlantic ASPB meeting 2025. They both won best poster presentation awards for their work on screening of the wheat and barley mutant populations for FHB resistance.

4. How have the results been disseminated to communities of interest?

The PI presented the results in oral presentations and disseminated updates on FHB in wheat and barley through emails. PI presented research updates in the FHB forum as well as online project update meetings. The graduate students in the team presented the results as posters and handouts to the stakeholders in commodity board meetings. The results were published as wheat trial Factsheets and were disseminated via emails and the UMD extension system to the broader grower community.

5. What do you plan to do during the next reporting period to accomplish the goals and objectives?

Work is in progress to identify new sources of FHB resistance. We already have promising results are we are working on mapping new sources of these resistance and susceptibility genes to develop markers for their tracking and integration in the breeding program. We have also identified some deletion and EMS mutant lines in highly susceptible lines (Jagger and Shirley). These lines have been now tested for multiple years in field and GH settings (Chhabra et al. 2021; https://doi.org/10.1094/PDIS-03-21-0670-RE) and 8 prominent mutants are being used for mapping the loci and their deployment in the breeding program.

PI will continue employing Speed Breeding to fast pace the integration of FHB resistant QTL and genes and to release FHB tolerant wheat cultivars. We are focused on integrating the promising new gene Fhb7 into our elite cultivars. Through Speed Breeding and recurrent backcrosses, we have advanced our germplasm to BC3F4 generations in 5 different MD cultivar's background and from this year we will start the field tests of this germplasm.

1. Developing DH lines with Fhb1 and Fhb7 genes in soft red winter wheat background.
2. Selected 300 backcross derivates are being tested to see the impact of the gene combination
3. Fall 2025-spring 2026: Test new lines in MD state test and misted Scab nursery to evaluate MD advanced lines along with Southern Uniform Scab Nursery, and Mason Dixon trials and their evaluation for yield, agronomic traits, and levels of deoxynivalenol (DON).
4. Summer 2025-Spring 2025: Evaluation of GAWN, Mason Dixon, Uniform Bread, Uniform Eastern Soft Red Winter Wheat, and Uniform Southern Soft Red Winter Wheat tests.
5. Summer 2025-Spring 2026: Genome wide marker data, including imputed presence of genes/QTL, genomic estimated breeding values and field phenotypic data are combined to make advancement decisions.
6. Advancing mapping studies to identify new locations providing resistance against FHB
7. Share the seeds of the adapted Fhb7 lines with regional breeders.
8. Data analysis and region-wide replicated trials of best performing lines and seed increases.
9. A new cycle of this timeline is initiated each year.